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Appl. No. 10/810,309
Amdt. Dated November 29, 2006
Reply to Final Office Action of September 19, 2006

Attorney Docket No. 81716.0122
Customer No. 26021

REMARKS/ARGUMENTS:

Claim 2 is amended. New claims 33-40 are added. Support for new claims 33-40 can be found in original claims 2, 6, 8, 10-13, and 19, respectively. Claims 2, 4, 6, 8, 10-13, 19, and 33-40 are pending in the application. Reexamination and reconsideration of the application, as amended, are respectfully requested.

The invention relates to a semiconductor apparatus and specifically relates to a semiconductor apparatus, a method for growing a nitride semiconductor and a method for producing a semiconductor apparatus which are suitable for a light emitting device and a light receiving device such as a light emitting diode (LED), a laser diode (LD), a solar cell and a photosensor, and an electronic device such as a transistor and a power device. (Applicant's specification, at p. 1, lines 7-14).

CLAIM REJECTIONS UNDER 35 U.S.C. § 103:

Claims 2, 4, 6, 8, and 19 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,588,468 to Hori et al. (or EP 1213767) in view of U.S. Patent No. 6,586,819 to Matsuoka. The Applicant respectfully traverses this rejection. Claim 2, as amended, is as follows:

A semiconductor apparatus comprising:

a substrate made of a diboride single crystal expressed by a chemical formula XB_2 , in which X includes at least one of Ti, Zr, Nb and Hf,

wherein an angle θ_1 formed by a normal line of a principal surface of the substrate and a normal line of a (0001) plane of the substrate is $0^\circ < \theta_1 \leq 0.55^\circ$;

a semiconductor buffer layer formed on the principal surface of the substrate and made of $(AlN)_x(GaN)_{1-x}$ ($0 < x \leq 1$); and

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a nitride semiconductor layer formed on the semiconductor buffer layer, including at least one kind or plural kinds selected from among 13 group elements and As, wherein the thickness of the semiconductor buffer layer made of $(\text{AlN})_x(\text{GaN})_{1-x}$ is within a range of 10 to 250 nm.

Applicant respectfully submits that the cited references cannot render amended claim 2 obvious because the cited references fail to teach or suggest that the thickness of the semiconductor buffer layer made of $(\text{AlN})_x(\text{GaN})_{1-x}$ is within a range of 10 to 250 nm.

It is an aspect of the present invention that the thickness of the semiconductor buffer layer made of AlN is selected in a range of 10 nm to 250 nm. In the case of less than 10 nm, the effect of the semiconductor buffer layer is insufficient and the scaly asperity exists on the surface of the nitride semiconductor layer formed on the semiconductor buffer layer. In the case of larger than 250 nm, film quality of the nitride semiconductor layer formed on the semiconductor buffer layer becomes bad, and a crystal layer as the nitride semiconductor layer formed on the semiconductor buffer layer, which crystal layer is formed above a crystal plane of the substrate via the semiconductor buffer layer, degrades. (Applicant's specification, at p. 24, line 17-p. 25, line 3).

Neither Hori nor Matsuoka teach or suggest that the thickness of the semiconductor buffer made of either $(\text{AlN})_x(\text{GaN})_{1-x}$ or AlN is within a range of 10-250 nm.

However, the Office states,

"But Hori discloses the semiconductor apparatus of claim 8, wherein the thickness of the semiconductor buffer made of AlN is about 500 nm, column 6, line 4. Accordingly, it would have been obvious to one of ordinary skill in art to use the thickness of Hori in the

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range as claimed, because it has been held that where the general conditions of the claims are disclosed in the prior art, it is not inventive to discover the optimum or workable range by routine experimentation."

The Applicant respectfully disagrees. The present invention teaches the criticality of the claimed range. As discussed above, the Applicant's specification teaches that the beneficial effects of the semiconductor buffer layer are the most favorable when the thickness of the semiconductor buffer layer made of $(\text{AlN})_x(\text{GaN})_{1-x}$ is within the claimed range, thus demonstrating the criticality of the claimed range. Therefore, the thickness of the semiconductor buffer layer in the context of the present invention cannot be a result effective variable given the criticality of the range taught by the present invention.

MPEP 2144.05(II)B states,

"A particular parameter must first be recognized as a result-effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges of said variable might be characterized as routine experimentation."

The Applicant respectfully submits that there is nothing in the cited references to indicate that results of the present invention could be achieved by optimizing the thickness of the semiconductor buffer layer. Consequently, the "thickness" of the present invention does not satisfy the result-effective variable requirements.

Furthermore, Hori at column 6, lines 3-5, states,

"Therefore, it is desired that the thickness of the underlayer 2 is set to 0.5 μm or over, particularly within a range of 1-3 μm ."

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Therefore, Hori teaches that the thickness be greater than 500 nm and not within a range of 10-250 nm. Consequently, Hori teaches away from the present invention.

"A prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention." MPEP 2141.02

Therefore, without the benefit of the Applicant's disclosure, there would have been no incentive or reason for one of ordinary skill in the art to arrive at the range taught by the present invention.

Matsuoka cannot remedy the defect of Hori and is not relied upon by the Office for such. Instead, the Office cites Matsuoka for teaching a semiconductor apparatus wherein an angle θ_1 (tilt angle) formed by a normal line of a principal surface of the substrate and a normal line of a (0001) plane of the substrate is $0^\circ < \theta_1 \leq 2^\circ$.

In addition, the Applicant respectfully submits that although the Office states that Matsuoka teaches that the angle θ_1 is in the range $0^\circ < \theta_1 \leq 2^\circ$ (col. 8, line 38), the actual range that is taught is $0.1^\circ \leq \theta_1 \leq 2^\circ$. Even though the value of θ_1 in Matsuoka partly overlaps that of the present invention ($0^\circ < \theta_1 \leq 0.55^\circ$), the purpose of setting θ_1 in the present invention is different than that of Matsuoka. The purpose for setting θ_1 to such an angle in the present invention is for better lattice alignment. In contrast, in Matsuoka, the purpose is for prevention of step formation on the GaN layer. The different purposes are due to the differences in the materials that the substrates are made of; Matsuoka uses a sapphire substrate while the present invention uses ZrB_2 or other similar material.

In light of the foregoing, Applicant respectfully submits that the cited references could not have rendered obvious claim 2, because the cited references fail to teach or suggest each and every claim limitation. Claims 4, 6, 8, and 19 depend

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from claim 2 and cannot be rendered obvious for at least the same reasons as claim 2. Withdrawal of these rejections is thus respectfully requested.

Claims 10-13 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Hori and Matsuoka and further in view of U.S. Patent No. 6,586,819 to Koike et al. (or EP 1263031). The Applicant respectfully traverses this rejection.

Claims 10-13 depend from claim 2 and therefore, cannot be rendered obvious over Hori and Matsuoka for the reasons discussed above. Koike cannot remedy the defect of Hori and Matsuoka and is not relied upon by the Office for such. Instead, the Office cites Koike for teaching a buffer layer having the composition of $\text{Al}_x\text{Ga}_{1-x}\text{N}$ ($0 \leq x \leq 1$).

In light of the foregoing, Applicant respectfully submits that the cited references could not have rendered obvious claims 10-13, because the cited references fail to teach or suggest each and every claim limitation. Withdrawal of this rejection is thus respectfully requested.

New claims 33-40 are believed to be patentable over the cited references for the reasons discussed above. In addition, Applicant notes that Hori only teaches ZnB_2 and not TiB_2 as is required by new claims 33-40.

Applicant believes the foregoing amendments comply with requirements of form and thus may be admitted under 37 C.F.R. § 1.116(b). Alternatively, if these amendments are deemed to touch the merits, admission is requested under 37 C.F.R. § 1.116(c). In this connection, these amendments were not earlier presented because they are in response to the matters pointed out for the first time in the Final Office Action.

Lastly, admission is requested under 37 C.F.R. § 1.116(b) as presenting rejected claims in better form for consideration on appeal.

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In view of the foregoing, it is respectfully submitted that the application is in condition for allowance. Reexamination and reconsideration of the application, as amended, are requested.

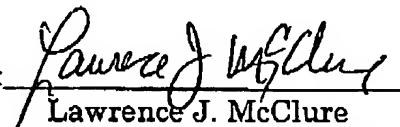
If for any reason the Examiner finds the application other than in condition for allowance, the Examiner is requested to call the undersigned attorney at the Los Angeles, California telephone number (310) 785-4600 to discuss the steps necessary for placing the application in condition for allowance.

If there are any fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 50-1314.

Respectfully submitted,
HOGAN & HARTSON L.L.P.

Date: November 29, 2006

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